

NATURAL RESOURCES CONSERVATION SERVICE CONSERVATION PRACTICE STANDARD

NUTRIENT MANAGEMENT

(Ac.)

CODE 590

DEFINITION

Managing the amount, source, placement, form and timing of the application of plant nutrients and soil amendments.

PURPOSE

- To budget and supply nutrients for plant production.
- To properly utilize manure or organic by-products as a plant nutrient source.
- To minimize agricultural nonpoint source pollution of surface and ground water resources.
- To protect air quality by reducing nitrogen emissions (ammonia and NO_x compounds) and the formation of atmospheric particulates.
- To maintain or improve the physical, chemical and biological condition of soil.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all lands where plant nutrients and soil amendments are applied.

CRITERIA

General Criteria Applicable to All Purposes

A nutrient budget for nitrogen, phosphorus, and potassium for the crop rotation shall be developed that considers all manageable sources of nutrients including, but not limited to animal manure and organic by-products, waste water, commercial fertilizer, crop residues, manure history credits, legume credits, and irrigation water.

Realistic yield goals shall be established based on soil productivity information, historical yield data, climatic conditions, level of management and/or research on similar soil, cropping systems, soil tests and manure/organic by-products application history.

For new crops or varieties, industry yield recommendations may be used until documented yield information is available.

Plans for nutrient management shall specify the source, amount, timing and method of application of nutrients on each field or CMU to achieve realistic production goals, while minimizing movement of nutrients to surface water and/or ground waters.

A Conservation Management Unit (CMU) is a field, group of fields, or other land units of the same land use and having similar treatment needs and planned management. A CMU is a grouping by the planner to simplify planning activities and facilitate the development of conservation planning systems. A CMU has definite boundaries, such as fence, drainage, vegetation, topography, or soil lines.

Areas contained within established minimum application setbacks (e.g., sinkholes, wells, gullies, ditches, surface inlets or rapidly permeable soil areas) shall not receive direct application of nutrients.

Potential for nutrient loss due to erosion, runoff, irrigation, volatilization and drainage, shall be addressed, as needed.

Soil and Tissue Sampling and Laboratory Analyses (Testing). Nutrient planning shall be based on current soil and tissue (where plant tissue is used as a supplement) test results developed in accordance with the

Pennsylvania State University (PSU) guidance, or industry practice if recognized by PSU. Current soil tests are those that are no older than three years.

Soil and/or tissue samples shall be collected and prepared according to PSU guidance or industry practice. Soil test analyses shall be performed by laboratories successfully meeting the requirements and performance standards of the North American Proficiency Testing Program (NAPT) under the auspices of the Soil Science Society of America. Soil samples shall be collected for each area receiving nutrients and soil amendments.

Soil and tissue testing shall include analyses for any nutrients for which specific information is needed to develop the nutrient plan. Request analyses pertinent to monitoring or amending the annual nutrient budget and include, as a minimum, analysis for pH, phosphorus and potassium.

Nutrient Application Rates. Soil amendments shall be applied, as needed, to adjust soil pH to an adequate level for crop nutrient availability and utilization.

Recommended nutrient application rates shall be based on PSU recommendations (and/or industry practice when recognized by PSU) that consider current soil test results, realistic yield goals and management capabilities. If Penn State does not provide specific recommendations, application shall be based on realistic yield goals and associated plant nutrient uptake rates.

The planned rates of nutrient application, as documented in the nutrient budget, shall be determined based on the following guidance:

- **Nitrogen Application** - Planned nitrogen application rates shall match, without exceeding, the recommended rates as closely as possible, except when manure or organic by-products are a source of nutrients. When manure or organic by-products are a source of nutrients, see "Additional Criteria" below.
- **Phosphorus Application** - Planned phosphorus application rates shall match the recommended rates as closely as possible, except when manure or organic by-products are sources of nutrients.

When manure or organic by-products are a source of nutrients, see "Additional Criteria" below.

- **Potassium Application** - Potassium shall not be applied in situations in which excess (greater than soil test potassium recommendation) causes unacceptable nutrient imbalances in crops or forages. When forage quality is an issue associated with excess potassium application, PSU recommendations should be used to set forage quality guidelines.
- **Other Plant Nutrients** - The planned rates of application of other nutrients shall be consistent with PSU guidance or industry practice if recognized by PSU.
- **Starter Fertilizers** - When starter fertilizers are used, they shall be included in the overall nutrient budget, and applied in accordance with PSU recommendations, or industry practice if recognized by PSU.
- **Planned application rates of nutrients and soil amendments** shall be based on the practical capability of the application equipment.

Nutrient Application Timing. Timing and method of nutrient application (particularly nitrogen) shall correspond as closely as practical with plant nutrient uptake characteristics, while considering cropping system limitations, weather and climatic conditions, risk assessment tools (e.g., P index) and field accessibility.

Nutrient Application Methods. Application methods to reduce the risk of nutrient transport to surface and ground water, or into the atmosphere shall be employed.

To minimize nutrient losses:

- Apply nutrient materials uniformly or as prescribed by precision agricultural techniques to application area(s).
- Nutrients shall not be applied to frozen, snow-covered or saturated soil if the potential risk for runoff exists.
- Nutrients shall be applied considering the plant growth habits, irrigation practices, and other conditions so as to maximize availability to the plant and minimize the

risk of runoff, leaching, and volatilization losses.

- Nutrient applications associated with irrigation systems shall be applied in a manner that prevents or minimizes resource impairment.

Conservation Management Unit (CMU) Risk Assessment. In areas with identified or designated nutrient related water quality impairment, the Pennsylvania Phosphorus Index (P-Index), a phosphorus loss risk-assessment tool, shall be completed to determine the potential for nutrient transport from each CMU

Additional Criteria Applicable to Manure and Organic By-Products or Biosolids Applied as a Plant Nutrient Source

When animal manures or organic by-products are applied to a CMU, the Pennsylvania Phosphorus-Index (P-Index) shall be completed to adjust the amount, placement, form and timing of application of nutrient sources, as recommended by Penn State.

Manure may not be mechanically applied in fall on a CMU having less than 25% plant cover or crop residue at the time of application, unless the CMU is planted to a cover crop in time to allow for appropriate growth (80% ground cover 4-6" of growth by December 1) to control runoff until the next growing season, or the manure is injected or mechanically incorporated within 5 days.

Winter is December 15 to February 28, or anytime the ground is frozen at least 4 inches deep or is snow covered.

For winter application of manure, the following apply:

1. The application procedure shall be described in the plan
2. The plan must list the following:
 - a. The CMUs where winter application is planned or restricted
 - b. The application procedures that will be utilized at those CMUs.
 - c. The field conditions that must exist for winter application.

3. Fields where manure will be applied in winter must have at least 25% residue, or an established cover crop.

Nutrient values of manure and organic by-products shall be determined prior to land application. Collect, prepare and analyze samples for each unique manure group according to PSU guidance. Include percent solids, total N, ammonium N, P, and K.

During the first year of a new operation, a new manure storage facility or the first year of nutrient management planning with no current manure analyses available, Utilize book values from a current PSU Agronomy Guide or NRCS Ag Waste Management Field Handbook. Revise the manure nutrient levels in the nutrient management plan with nutrient values from actual samples on a yearly basis.

Sample each unique manure group annually until the average of the analyses becomes consistent over a period of three or more years. When possible, always base manure application rates on average of manure analyses within each discrete manure group. Continue to base manure application rates on the consistent manure analysis history. When a change in animal husbandry or manure handling management occurs, new consistent manure analysis nutrient values shall be determined as described in this paragraph.

Biosolids (sewage sludge) shall be applied in accordance with USEPA regulations, (40 CFR Parts 403 (Pretreatment) and 503 (Biosolids) and Pennsylvania Code Title 25, Chapter 271, Subchapter J: Beneficial Use of Sewage Sludge by Land Application.

Manure and Organic By-Product Nutrient Application Rates. Manure and organic by-product nutrient application rates shall be based on nutrient analysis procedures recommended by PSU or industry practice recognized by PSU.

Manure and other organics (biosolids) shall be applied in accordance with all Federal, State, and local regulations.

The application rate (in/hr) of liquid materials applied shall not exceed the soil intake/infiltration rate and shall be adjusted to minimize ponding and to avoid runoff. Refer to NRCS Land Application Techniques chapter in

the Livestock Waste Facilities Handbook. The total application shall not exceed the field capacity of the soil and shall be adjusted, as needed to minimize loss to subsurface tile drains.

The planned rates of nitrogen and phosphorus application recorded in the plan shall be determined based on the following guidance:

Nitrogen Application Rates

- Credit all residual nitrogen credits from organic nutrient and legumes when calculating nitrogen rates in the nutrient budget.
- When manure or organic by-products are used, the nitrogen availability of the planned application rates shall match, plant uptake characteristics as closely as possible, taking into consideration the timing of nutrient application(s) in order to minimize leaching and atmospheric losses.
- Management activities and technologies shall be used that effectively utilize mineralized nitrogen and that minimize nitrogen losses through denitrification and ammonia volatilization.
- Manure or organic by-products may be applied on legumes at rates equal to the estimated removal of nitrogen in harvested plant biomass.
- When the nutrient management plan component is being implemented on a phosphorus basis, manure or organic by-products shall be applied at rates consistent with a phosphorus limited application rate. In such situations, an additional nitrogen application, from non-organic sources, may be required to supply, but not exceed, the recommended amounts of nitrogen in any given year.

Phosphorus Application Rates

When manure or organic by-products are used, the planned rates of phosphorus application rates shall be consistent with the P-Index rating. Nitrogen-limited manure application rates on Low or Medium rated sites, phosphorus-limited manure application rates on High rated sites and no manure or P application on Very High rated sites.

The application of phosphorus applied as manure on P-limited basis may be made at a

rate equal to the recommended phosphorus application or estimated phosphorus removal in harvested plant biomass for the crop rotation or multiple years in the crop sequence. When such applications are made, the application rate shall:

- ◇ Not exceed the recommended nitrogen application rate during the year of application, or not exceed the estimated nitrogen removal in harvested plant biomass during the year of application when there is no recommended nitrogen application.
- ◇ Not be made on sites considered vulnerable to off-site phosphorus transport unless appropriate conservation practices, best management practices or management activities are used to reduce the vulnerability.

Heavy Metal Monitoring. When biosolids (sewage sludge) is applied, the accumulation of potential pollutants (including arsenic, cadmium, copper, lead, mercury, selenium, and zinc) in the soil shall be monitored in accordance with the US Code, Reference 40 CFR, Parts 403 and 503, and applicable State and local regulations.

Additional Criteria to Protect Air Quality by Reducing Nitrogen and/or Particulate Emissions to the Atmosphere

In areas with an identified or designated nutrient management related air quality concern, any component(s) of nutrient management (i.e., amount, source, placement, form, timing of application) identified by risk assessment tools as a potential source of atmospheric pollutants shall be adjusted, as necessary, to minimize the loss(es).

When tillage is performed, surface applications of manure and fertilizer nitrogen formulations that are subject to volatilization on the soil surface (e.g., urea) shall be incorporated into the soil within 24 hours. One-half inch of soaking rain is equivalent to tillage for incorporation of volatile nitrogen compounds.

When manure or organic by-products are applied to grassland, hayland, pasture, mulch-till, or no-till areas the rate, form and timing of application(s) shall be managed to minimize volatilization losses. Management techniques may include manure injections and planning

application of manure on soils ahead of light to moderate rainfall.

When liquid forms of manure are applied with irrigation equipment, operators will make applications when weather conditions minimize volatilization losses.

Operators will handle and apply poultry litter or other dry types of animal manures when the potential for wind driven loss is low and there is less potential for transport of particles into the atmosphere.

Weather and climatic conditions during manure or organic by-product application(s) shall be recorded and maintained in accordance with the operation and maintenance section of this standard.

Additional Criteria to Improve the Physical, Chemical and Biological Condition of the Soil

Nutrients shall be applied and managed in a manner that maintains or improves the physical, chemical and biological condition of the soil.

Minimize the use of nutrient sources with high salt content unless provisions are made to leach salts below the crop root zone.

To the extent practicable nutrients shall not be applied when there is potential for soil compaction and rutting.

CONSIDERATIONS

The use of management activities and technologies listed in this section may improve both the production and environmental performance of nutrient management systems.

The addition of these management activities, when applicable, increases the management intensity of the system and is recommended in a nutrient management system.

Action should be taken to protect National Register listed and other eligible cultural resources.

The nutrient budget should be reviewed annually to determine if any changes are needed for the next planned crop.

Sample the soil surface for phosphorus accumulation and pH changes on sites with special environmental concerns.

Use actual, current nutrient management implementation records annually to budget for the following cropping season.

Excessive levels of some nutrients can cause induced deficiencies of other nutrients.

To manage the conversion of nitrogen in manure or fertilizer consider using products or materials (e.g. nitrification inhibitors, urease inhibitors and slow or controlled release fertilizers) that more closely match nutrient release and availability for plant uptake. These materials may improve the nitrogen use efficiency (NUE) of the nutrient management system by reducing losses of nitrogen into water and/or air.

CAFO operations seeking permits under USEPA regulations (40 CFR Parts 122 and 412) should consult with Pennsylvania Department of Environmental Protection. CAO operations seeking approved nutrient management plans should consult with the State Conservation Commission Nutrient Management Program for Act 38. All operations applying manure must follow the current DEP Manure Management Manual for Environmental Protection.

Considerations to Minimize Agricultural Nonpoint Source Pollution of Surface and Ground Water

Erosion control and runoff reduction practices can improve soil nutrient and water storage, infiltration, aeration, tilth, diversity of soil organisms and protect or improve water and air quality (Consider installation of one or more NRCS FOTG, Section IV-Conservation Practice Standards).

Use cover crops whenever possible to protect the soil surface, add biomass, and recycle nitrogen and other nutrients. See NRCS Conservation Practice Standard Cover Crop (code 340).

Nutrient applications associated with irrigation systems should be applied in accordance with the requirements of NRCS Conservation Practice Standard Irrigation Water Management (Code 449).

Modify animal feed rations, based on technology to reduce the manure nutrient content. See NRCS Conservation Practice Standard Feed Management (code 592).

Apply nutrient materials uniformly to the application area. Application methods and timing that reduce the risk of nutrients being transported to ground and surface waters, or into the atmosphere include:

- Spilt applications of nitrogen to provide nutrients at the times of maximum crop utilization,
- Pre-sidress Soil Nitrate Test (PSNT) or Chlorophyll Meter Test may be used as in-season management tools to improve nitrogen management when used according to PSU guidance.
- Use Late Season Cornstalk Nitrate Test to assess overall nitrogen management.
- Avoid winter nutrient application for spring seeded crops.
- Band applications of phosphorus fertilizer near the seed row.
- Incorporate surface applied manures or organic by-products as soon as possible after application to minimize nutrient losses.
- Apply manure or organic by-products on hayland immediately after harvest.
- Delay field application of animal manures or organic by-products if precipitation capable of producing significant runoff and erosion is forecast within 24 hours of the time of the planned application.

Considerations to Protect Air Quality by Reducing Nitrogen and/or Particulate Emissions to the Atmosphere

Minimize the impact of odors of land-applied organic manures by making application at times when temperatures are cool and when wind direction is away from neighbors or by incorporation or injection. Avoid applying these materials upwind of occupied dwellings when they are likely to be occupied (evenings, weekends, etc.).

When irrigating with manure, equipment modifications can reduce the potential for volatilization (e.g., reduced pressure, drop down tubes for center pivots). N volatilization in a surface irrigation system will be reduced when applied under a crop canopy.

Volatilization, the major nitrogen loss mechanism, may occur when manure and urea fertilizers are not incorporated by tillage or rainfall. Other technologies (e.g. urease inhibitors, no-till injectors) may also be used to reduce volatilization.

Encourage soil carbon build up when planning nutrient applications and tillage operations. Discourage greenhouse gas emissions (e.g. nitrous oxide, carbon dioxide).

PLANS AND SPECIFICATIONS

Plans and specifications for nutrient management shall be in keeping with this standard and describe the requirements for applying the practice to achieve its intended purpose(s), using nutrients to achieve production goals and to prevent or minimize resource impairment.

Nutrient management plans shall include a statement that the plan was developed based on requirements of the current standard and any applicable Federal, state, or local regulations, policies, or programs, which may include the implementation of other practices and/or management activities. Changes in any of these requirements may necessitate a revision of the plan.

Plan writers are highly encouraged to follow the standard format established in the Pennsylvania Act 38 of 2005 for elements of a 590 plan also required for an Act 38 plan.

The following components shall be included in the nutrient management plan:

- aerial site photograph(s) or site map(s), and a soil survey map of the site,
- location of designated sensitive areas or resources and the associated nutrient management restriction,
- current and/or planned plant production sequence or crop rotation,

- results of soil, manure and/or organic by-product sample analyses,
- results of plant tissue analyses, when used for nutrient management,
- realistic yield goals for the crops,
- complete nutrient budget for nitrogen, phosphorus, and potassium for the crop rotation or sequence,
- if increases in soil phosphorus levels are expected, the nutrient management plan shall document the results of the P Index.
- listing and quantification of all nutrient sources,
- CMU specific recommended nutrient application rates, timing, form, and method of application and incorporation, and
- guidance for implementation, operation, maintenance, and recordkeeping.

If increases in soil phosphorus levels are expected, the nutrient management plan should document:

- the soil phosphorus levels at which it may be desirable to convert to phosphorus based planning,
- results of appropriate risk assessment tools to document the relationship between soil phosphorus levels and potential for phosphorus transport from the field,
- the potential for soil phosphorus drawdown from the production and harvesting of crops, and
- management activities or techniques used to reduce the potential for phosphorus loss.

OPERATION AND MAINTENANCE

The owner/client is responsible for safe operation and maintenance of this practice including all equipment. Operation and maintenance addresses the following:

- Records to document plan implementation. As applicable, records include:
 - Soil, plant tissue, manure, and organic by-product analyses resulting in

recommendations for nutrient application,

- quantities, analyses and sources of nutrients applied,
- dates and method(s) of nutrient applications,
- lapsed time between manure incorporation, rainfall or irrigation event.
- crops planted, planting and harvest dates, yields, and crop residues removed,
- dates of plan review, name of reviewer, and recommended changes resulting from the review.

Records should be maintained for three years; or for a longer period if required by other Federal, state or local ordinances, or program or contract requirements.

- Periodic plan review to determine if adjustments or modifications to the plan are needed. As a minimum, plans will be reviewed and revised with each three-year soil test cycle.
- Significant changes in animal numbers and/or feed management will necessitate additional manure sampling and analyses to establish a revised average nutrient content.
- Protection of fertilizer and organic by-product storage facilities from weather and accidental leakage or spillage.
- Calibration of application equipment to ensure uniform distribution of material at planned rates.
- Documentation of the actual rate at which nutrients were applied. When the actual rates used differ from the recommended and planned rates, records will indicate the reasons for the differences.

Workers should be protected from and avoid unnecessary contact with plant nutrient sources. Extra caution must be taken when handling ammoniacal nutrient sources, or when dealing with organic wastes stored in unventilated enclosures.

Material generated from cleaning nutrient application equipment should be utilized in an environmentally safe manner. Excess material

should be collected and stored or field applied in an appropriate manner.

Nutrient containers should be recycled in compliance with state and local guidelines or regulations.

REFERENCES

Midwest Plan Service Livestock Waste Facilities Handbook 3rd ed. MWPS-18 (1993).

Pennsylvania Department of Environmental Protection 2001. Manure Management for Environmental Protection and its Supplements.
http://panutrientmgmt.cas.psu.edu/pdf/rp_manure_mgmt.pdf
http://panutrientmgmt.cas.psu.edu/pdf/rp_field_app_manure.pdf

PSU College of Agricultural Sciences
 Agronomy Guide Current Edition
<http://agguide.agronomy.psu.edu/>

PSU Agricultural and Biological Engineering
 Fact Sheets:

- [Irrigation of Liquid Manures \(F254\)](#)
- [Irrigation of Liquid Manures with a Traveling Gun \(F255\)](#)
- [Irrigation of Liquid Manures with Center-Pivot Irrigation Systems \(F256\)](#)
- [Irrigation of Liquid Manures with Solid Set Systems \(F257\)](#)

PSU College of Agricultural Sciences, The Phosphorus Index Current Version
http://panutrientmgmt.cas.psu.edu/pdf/phosphorus_index_factsheet.pdf

PSU College of Agricultural Sciences
 Environmental Soil Issues fact sheet Land Application of Sewage Sludge in Pennsylvania
<http://cropsoil.psu.edu/extension/esi.cfm>

- A Plain English Tour of the Regulations (1999).
- Use of Biosolids in Crop Production (1999).

The Pennsylvania State Conservation Commission, Pennsylvania Nutrient Management Program Technical Manual, Current Edition

http://panutrientmgmt.cas.psu.edu/rp_technical_manual.htm

Pennsylvania Act 38 of 2005, ACRE Provisions Relating to: Review of Local Ordinances and Nutrient Management and Odor Management.

PSU Agronomy Facts Agronomy Fact Sheets:
<http://cropsoil.psu.edu/extension/facts/agfacts.cfm>

Agronomy Facts 17 Pre-sidedress Soil Nitrate Test Agronomy Fact Sheet

Agronomy Facts 53 The Early-season Chlorophyll Meter Test for Corn Agronomy Fact Sheet

Agronomy Facts 54 Pennsylvania's Nutrient Management Act: Who Will Be Affected? Fact Sheet

Agronomy Facts 60 Nutrient Management Planning – Overview Fact Sheet

PSU Agricultural Analytical Services
 Laboratory - Late Season Cornstalk Nitrate Test:
http://www.aasl.psu.edu/Corn_stalk_nitrate.html

USDA NRCS Core4 Conservation Practices: The Common Sense Approach to Natural Resource Conservation (August 1999) – Nutrient Management section.
<http://www.nrcs.usda.gov/TECHNICAL/ECS/agronomy/core4.pdf>

PA Code Title 25 Chapter 271 Subchapter J Beneficial Use of Sewage Sludge by Land Application.